

## **Provide the FORA for ONR Sponsored NPAL 04 Experiment**

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### **LONG-TERM GOALS**

Provide for towed array operation and data collection using the Five Octave Research Array (FORA) in support of the 2004 North Pacific Acoustic Laboratory Experiment.

### **OBJECTIVES**

Provide data collection and archiving capabilities for deep-water long-range acoustic propagation experiments in support of acoustic propagation, coherence, and fluctuation studies.

Gain understanding of fundamental limits to signal processing imposed by oceanographic and environmental conditions including internal waves, breaking sea surface waves, shipping noise, and bathymetric effects.

### **APPROACH**

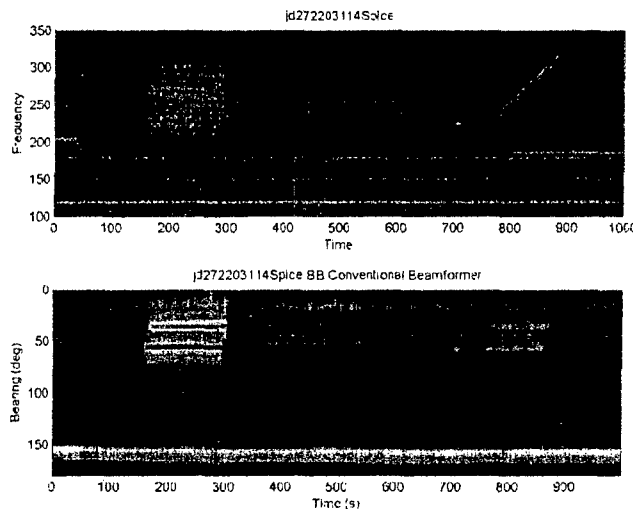
The new ONR Five Octave Research Array (FORA) was prepped and shipped to Honolulu, HI for installation aboard the R/V Roger Revelle for a 1 month sea-trial. The system was configured to collect data as required by the Chief Scientists (A.B. Baggeroer and K.D. Heaney) in accordance with the test plan. The array was operated almost continuously throughout the sea-trial with 4 operators working in pairs, each pair taking a 12 hour shift. Array attitude (depth and heading) and acoustic channel data were continuously monitored to insure proper and safe operations. Array operators were also responsible for data acquisition, archiving, and redistribution throughout the course of the sea trial. Locally, data were archived on Ultra 320 SCSI disk drives and also transferred via FTP to MIT/WHOI machines for duplication and data processing.

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## WORK COMPLETED

The FORA was mobilized and installed on the R/V Roger Revelle for the 2004 NPAL/BASSEX sea trial. The array was in operation for over 350 hrs over 22 days at sea. The array was deployed as both a towed array and a vertical array. 4500 Gbytes of data was collected in 316 files capturing over 900 acoustic transmissions. Transmission times and corresponding file sized varied from 20 minutes/10 Gbytes to over 80 minutes/30 Gbytes. Of the 160 acoustic channels recorded, 3 were found to be bad during the sea trial. At the conclusion of the sea trial, the array was removed from the ship, packaged and shipped back to Penn State.

## RESULTS



*Figure 1: Sample FORA reception for simultaneous S1 and S2 transmissions*

The FORA was successfully employed during the NPAL 04 experiments to collect over 4500 Gbytes of high-fidelity acoustic propagation data. Preliminary science results can be found in [1][2]. Data quality for this first deep-water, long-range propagation application of the FORA was very high. Fig. 1 shows data on a single channel along with the beam-formed output for sources S1 and S2 transmitting simultaneously 135 s M-sequences follow by LFM sweeps. The two sources were separated by a distance of 500 km with the receiver towed from North to South along a line between them. During a particular reception, the ship was steered at an angle to the two sources to separate the arrivals in beam space. Taking a closer look at the acoustic data it was determined that the array sampling clocks would periodically lose synchronization on select channels during a

recording. The source of the error was identified while at sea and a software fix has been proposed for future sea trials. During the sea trial, the array attitude proved to be stable and well behaved either when towed or deployed vertically. The array depth and horizontal tilt are shown as tow speed is increased incrementally in Fig. 2.

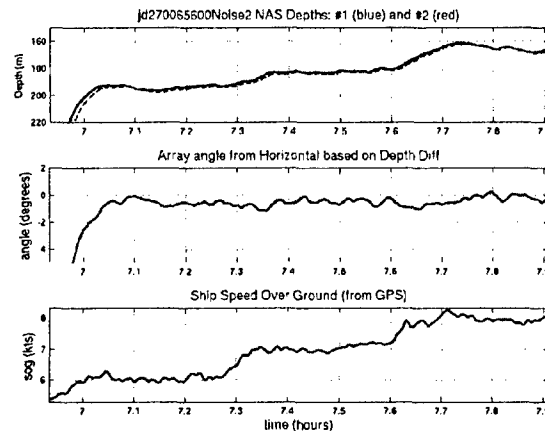


Figure 2: FORA depth and horizontal tilt as a function of tow speed. Depth sensors are separated by 108 m.

## IMPACT/APPLICATIONS

This was the first deep water application of the FORA. The array proved to be a versatile tool for deep water long range propagation work. The array data acquisition system and clock schemes will be will continue to be refined and updated to meet the needs of future experimental work using the FORA.

## RELATED PROJECTS

The FORA was used in the ONR Ocean Acoustics sponsored GeoClutter experiment in 2003.

## PUBLICATONS

[1] A.B. Baggeroer and K.D. Heaney, Forward Scattering from the Kermit-Roosevelt Seamount complex during the BASSEX -LOAPEX-SPICEX experiments, *Proceedings of the 1<sup>st</sup> International Conference on Underwater Acoustic Measurements: Technologies & Results*, eds. J.S. Papadakis and L Bjorno, Heraklion, Greece (28 June – 1 July, 2005)

[2] K.D. Heaney, A.B. Baggeroer, K.M. Becker, E.K. Scheer, and K. von der Heydt, Range Dependent Propagation off a Seamount, *Proceedings of the 1<sup>st</sup> International Conference on Underwater Acoustic Measurements: Technologies & Results*, eds. J.S. Papadakis and L Bjorno, Heraklion, Greece (28 June – 1 July, 2005)

K.M. Becker, A.B. Baggeroer, K.D. Heaney, E.K. Scheer, and K. von der Heydt, ONR Five-Octave Research Array Performance during BASSEX 04, *Proceedings of the 1<sup>st</sup> International Conference on Underwater Acoustic Measurements: Technologies & Results*, eds. J.S. Papadakis and L Bjorno, Heraklion, Greece (28 June – 1 July, 2005)

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